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Preparation of Mesoporous Activated Carbon from Banana Peel by Hot-Water Deashing and CO_2 Activation

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ABSTRACT

Bananas are among the most widely consumed fruits worldwide, and large quantities of banana peels are generated as agricultural waste. In this study, the preparation of activated carbon from banana peels was investigated. Banana peels contain a large amount of ash, mainly potassium chloride (KCl). When carbonization and activation are carried out without pretreatment, a significant amount of ash remains in the resulting activated carbon. In addition, KCl acts as a catalyst during activation, leading to excessive activation and preventing the desirable development of pore structures. To address this issue, banana peels were carbonized at 500-1000 °C, followed by deashing with hot water. The obtained deashed char was then activated using carbon dioxide at 850 °C to produce activated carbon.

The results showed that 70–80% of the ash in the char could be removed by hot-water washing, regardless of the carbonization temperature. Deashing significantly increased the specific surface area and pore volume of the char. This increase is attributed to the formation of pores after the removal of ash components.

Activated carbon was further prepared by CO_2 activation of the char obtained after deashing at 900 °C. The activation was conducted at 850 °C for up to 4 h. The deashing treatment reduced the activation rate, enabling the activation reaction to proceed more uniformly throughout the internal pore structure. As a result, both the specific surface area and pore volume increased. After 4 h of activation, mesoporous activated carbon with a specific surface area of 1700 $m^2\ g^{-1}$ was obtained, with mesopores accounting for approximately 45% of the total pore volume.

Water vapor adsorption isotherms were measured at 25 °C to evaluate the surface properties of the prepared activated carbon. The results showed a relatively high adsorption capacity at low humidity, indicating that the activated carbon's surface exhibits hydrophilic characteristics. This hydrophilicity is attributed to nitrogen-containing functional groups derived from the banana peel precursor.

These results demonstrate that hot-water deashing is an effective pretreatment for controlling ash content and pore development in banana peel–derived activated carbon, enabling the production of mesoporous activated carbon with a high specific surface area.

KEY WORDS

Activated carbon, Mesoporous, Deashing, Banana peel

BIOGRAPHY

Jun'ich Hayashi is a professor at Kansai University, Japan. His research focuses on the preparation and characterization of porous carbon materials derived from biomass wastes. His current research investigates the production of activated carbon from biomass waste through deashing and CO_2 activation, aiming to develop sustainable adsorbents with high surface area and controlled pore structures. His research interests include biomass utilization, porous materials, and adsorption technology.

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